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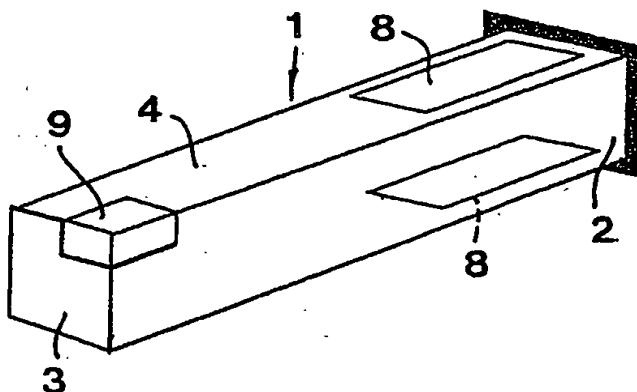
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International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/SE00/00242 <b>(22) International Filing Date:</b> 8 February 2000 (08.02.00)  <b>(30) Priority Data:</b> 9900441-8 10 February 1999 (10.02.99) SE  <b>(71) Applicant (for all designated States except US):</b> SANDVIK AKTIEBOLAG [SE/SE]; S-811 81 Sandviken (SE).  <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> LUNDBLAD, Mikael [SE/SE]; Gråbergsvägen 41, S-805 95 Gävle (SE).  <b>(74) Agent:</b> BENTON, Richard; Sandvik Aktiebolag, Patent Department, S-811 81 Sandviken (SE).		<b>(81) Designated States:</b> JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments. In English translation (filed in Swedish).</i>

**(54) Title:** ACTIVE ANTI-VIBRATION SYSTEM FOR CUTTING TOOLS



**(57) Abstract**

A tool for chip removing machining comprises a shank (1) having a clamping end (2) together with a machining element (9) at an opposite end. In the area near the clamping end (2), there are piezo-elements (8) having the purpose of dampening bending and/or torsional vibrations. The action of the piezo-elements on the shank may be controlled passively by means of a control module (14) including resistive components (or actively by means of a logical control circuit).

## ACTIVE ANTI-VIBRATION SYSTEM FOR CUTTING TOOLS

### Technical field of the invention

- 5 This invention relates to a tool intended for chip removing machining of the type that comprises a shank having a clamping end and having a machining element at an opposite end.

### Background to the invention

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- During chip removing machining, such as turning or drilling, problems often arise with vibration, specially in cases where the length of the shank or the tool is at least 4-5 times larger than the diameter thereof. One type of vibration is bending vibration, the shank being bent to and fro and submitted to bending deformations. This phenomenon
- 15 constitutes a common problem, for instance during turning, specially internal turning, where the shank in the form of a boring bar has to be long in order to reach the workpiece, at the same time as the diameter of the bar is limited by the dimension of the hole in which machining is carried out. During such drilling, turning and milling operations, where the distance to the workpiece is large, extension units are used, which
- 20 frequently cause bending vibration leading not only to deteriorated dimensional accuracy and irregularities in the workpiece, but also to reduced service life of the milling cutter and its cutting insert or the machining element thereof.

- Another type of vibration is torsional vibration, the shank being turned or screwed to
- 25 and fro around the longitudinal axis thereof during which shear strain is created. Such vibration arises, for instance, during drilling, specially at higher speed. Also torsional vibration leads to a poorer quality of the machined surface, as well as reduced service life of tools and cutting inserts. An important nuisance is also the working environment problem which torsional vibrations give rise to, in that a shrill noise is generated during
- 30 rotation.

Prior art

Dampening of vibrations in tools for chip removing machining has previously taken place by pure mechanical dampening, the shank being formed with a cavity in which a mass of, for instance, counter-vibrating heavy metal is applied. In doing so, the weight and the position of the mass is tuned in order to bring about dampening of the vibration within a certain range of frequencies. The cavity is then filled with a viscous liquid, e.g. oil, and is plugged. However, this technique works tolerably well only in those cases where the length of the shank is approx. 4-10 times longer than the diameter thereof. In addition to this limitation, the pure mechanical dampening has an obvious disadvantage inasmuch as the range of frequencies within which the dampening acts is very limited. An additional nuisance consists of the weakening of the structural strength, which the cavity formed in the shank entails.

In entirely different technology areas, a development of more efficient, adaptive dampening techniques, has been started with the utilization of, among other things, piezo-elements. A piezo-element consists of a material, most often of a ceramic type, which on compression or strain in a certain direction - the direction of polarization - generates an electric field in this direction. The piezo-element is usually in the shape of a rectangular plate with a direction of polarization, which is parallel to the major axis of the plate. By connecting the piezo-element to an electrical circuit, including a control module, and compressing or elongating the piezo-element in the direction of polarization, an electric current will be generated and flow in the circuit, electric resistive components included in the control module releasing heat according to known physics. In doing so, vibration energy is converted to thermal energy, whereby a passive dampening, but not totally neutralizing effect on the vibration is obtained. What is more, by forming the control module with a suitable combination of resistive and reactive components, so called shunts, selected frequencies may be brought to be dampened particularly effectively. Such frequencies are advantageously the so called "eigenvalue" frequencies of the exposed eigenmodes of the object in question, which are the ones that are especially excited.

Conversely, a piezo-element may be compressed or elongated by the fact that an electric voltage is applied over the piezo-element, and this may be used as a control device or operating device (actuator). This may, then be used for an active vibration reduction by the fact that the polarity of the applied electric voltage is chosen in such a way that the mechanical stress of the operating device acts in the opposite direction, as an external, mechanical stress, the emergence of vibration being suppressed by the fact that other kinetic energy, for instance energy of rotation, is not permitted to translate into vibration energy. The synchronization of the applied electric voltage in respect to the external mechanical tension, the effect of which should be counteracted, is then carried out by the fact that a feedback signal from a deformation sensitive sensor is fed to a control means in the form of a logical control circuit, e.g. a programmable microprocessor, in which the signal is processed to almost instantaneously control the electric voltage applied over the operating device. The control function, i.e. the relation between the input signal from the sensor and the output voltage, may then be made very complex. A self-learning system for adaptation to varying conditions is, for instance, feasible. The sensor may consist of a separate, deformation sensitive device, e.g. a second piezo-element, or be common with the operating device.

Examples of realized applications and current development areas for utilization of piezo-elements in vibration dampening purposes are described in Mechanical Engineering, Nov 1995, p. 76-81. Thus, skis for alpine skiing (K2 Four ski, K2 Corp., USA) have been equipped with piezo-element with the purpose of repressing undesired vibration, which otherwise decreases the contact with the ground and thereby reduces the skier's prospect of a stable and controlled skiing. Furthermore, applications such as increased wing stability of aeroplanes, improved comfort in motor vehicles, suppression of vibrations in rotor blades and shafts of helicopters, vibration reduction of machining platforms for flexible manufacture, and increased hit precision of military weapons are mentioned. In data sheets from Active Control eXperts (ACX) Inc., USA (manufacturer of piezo-elements) vibration reduction of snowboards is also mentioned.

### Objects and features of the invention

The present invention aims at managing the shortcomings of previously known tools for chip removing machining mentioned in the introduction and at providing a tool with an improved vibration dampening. Thus, a primary object of the invention is to provide a robust tool with the ability to efficiently dampening of vibrations over a wide range of frequencies, for instance where the length of the shank is 3-15 times larger than the diameter thereof, preferably approx. 4-6 times longer than the diameter thereof. It is also an object to provide a tool for chip removing machining having a longer service life for the tool itself as well as the cutting element thereof, compared to previously known tools. Additional objects of the tool are that the use thereof should lead to an increased quality of the surface of the machined workpiece and to an improved working environment by reduction of high frequency noise.

According to the invention, at least the primary object is attained by the features defined in the characterizing part of claim 1. Preferred embodiments of the invention are furthermore defined in the dependent claims.

### Brief Description of the Appended Drawings

In the drawings:

Fig 1 is a schematic side view of a long narrow body in the form of a tool shank during bending deformation during turning (1<sup>st</sup> resonance frequency),

Fig 2 is a graph showing the bending moment in the body,

Fig 3 is a side view of a cross sectional end portion of the body adjacent to a clamping end so as to illustrate the tension proportional to strain in the body during bending deformation,

Fig 4 is a schematic side view of a long narrow body during torsional or shear strain,

Fig 5 is a graph showing the torsional moment during the last-mentioned deformation,

- Fig 6 is a circular cross-section through the body according to fig 4 so as to illustrate the shear strain proportional to shear strains in the body,
- Fig 7 is a view of a portion of a body showing deformation of a surface portion during torsional stress,
- 5 Fig 8 is a transparent perspective view of a tool shank according to the invention,
- Fig 9 is a perspective view of a bar extender for milling tools formed with circular cross-section,
- Fig 10 is a side view of a drilling tool according to the invention,
- 10 Figs 11-13 are perspective views of tool shanks with quadratic cross-sections and in different alternative embodiments,
- Fig 14 is a perspective view of a tool for active vibration dampening mounted in a carrier, and
- Fig 15 is an analogous perspective view of an alternative embodiment for
- 15 passive vibration dampening.

#### Brief description of general deformation cases

20 In figs 1-7, different deformation cases during which oscillations or vibrations may arise are shown schematically.

In fig 1, a long narrow body is illustrated which may consist of a tool or a shank of a tool. The body 1 has a clamping end 2 and a free, outer end 3. The body has an external surface 4, which may consist of an envelope surface if the body is cylindrical. It may

25 also include a plurality of plane surfaces if the body has a polygonal, e.g. square cross-sectional shape. The body 1 may have an arbitrary cross-sectional shape, however, most are usually circular or square. In fig 1, numeral 5 designates a part in which the body 1 is clamped, the body extending console-like from the clamping part. In fig 1, the body 1 is shown in a state when it has been deformed in a first bending eigenmode.

30 Furthermore, a graph is shown in fig 2, which illustrates how the bending moment  $M_b$  in this case varies along the body. As is seen in the graph, a largest bending moment, and thus a largest strain, arises at or near the clamping end 2. The same is valid for all lower modes, which are normally dominating energy-wise during bending vibration of tools

for chip removing machining. In fig 3, a portion of the body 1 deformed by deflection in fig 1 is shown in the area of the clamping end. In doing so, how the strain at bending deformation varies in the cross-direction of the body (the strain is highly exaggerated for illustrative reasons) is illustrated. As is seen in the figure, the largest strains are  
5 obtained at the envelope or outer surface 4 of the body.

In fig 4, a long narrow body 1 is shown which has been deformed in a first torsional eigenmode. Furthermore, in fig 5 a graph is shown which illustrates how the torsional moment  $M_t$  in this case varies along the body. As is seen in the graph, the largest  
10 torsional moment, and thus the largest shear strain, is obtained closest the clamping part 5. The same is valid for all lower modes, which are normally dominating energy-wise during torsional vibration of tools for chip removing machining. In fig 6, a circular cross-section of the body 1 according to fig 4 is shown, illustrating how the shear strain at shear deformation varies along the diameter of the cross-section (the shear strain is  
15 highly exaggerated for illustrative reason). As is seen in the figure, the largest shear strain is obtained closest the envelope surface 4.

In fig 7, a portion of the body 1 is shown, illustrating deformation during torsional stress of two hypothetical, square surfaces 6, 7 applied on the envelope surface 4, which  
20 surfaces are oriented with the edges thereof along and perpendicularly, as well as in 45° degree's angle to the longitudinal extension of the body 1 (the deformation is highly exaggerated for illustrative reason). As is seen in the figure, the surface 6 will, at shear strain, be deformed to a rhombic shape, while the surface 7 is deformed to a rectangular shape. During bending deformation, essentially the opposite relationship will be  
25 obtained, in the case where the bending is carried out across the plane of the surfaces 6, 7, i.e. the surface 6 will be deformed to a rectangular shape, while the surface 7 is deformed to a rhombic shape.

#### Detailed description of preferred embodiments of the invention

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In fig 8, a fundamental design of a long narrow tool or shank 1 is shown schematically in which two flat-shaped, rectangular piezo-elements 8 are fastened on opposite, longitudinal plane surfaces 4 of the shank formed with square cross-section. The piezo-

elements 8 are placed in the area near the clamping end 2 of the shank. At the outer end 3 thereof, the shank has a machining element in the form of a cutting insert 9. Thus, the piezo-elements 8 are positioned in an area where the largest strain occurs at bending deformation as well as torsional deformation. Although this location is preferred, other locations are also feasible. Furthermore, the piezo-elements 8 are oriented with the major faces thereof essentially parallel to the plane surfaces 4 of the shank and with the major axes essentially parallel to the length extension of the shank 2, and the piezo-elements 8 during bending vibration will be deformed whilst retaining a rectangular shape, while the same at torsional vibration will be deformed to a rhombic shape (compare fig 7). The direction of polarization of the flat-shaped, rectangular piezo-elements is here, and in the following, assumed to be parallel to the major axes of the same, although another shape as well as another direction of polarization is feasible. Thereby, the piezo-elements act, at the orientation in question of the same, most efficiently for dampening of bending vibration, since the same in this case undergo a maximum average deformation along the direction of polarization.

The relationship between the size of the piezo-elements 8 and the size of the shank in fig 8 and the following figures should not be understood as limiting, but are only selected in order to make the exemplified location and orientation of the piezo-elements clear. The number of piezo-elements and their orientation shown in the figures should not be regarded as limiting but only as exemplifying. Neither need a plurality of piezo-elements formed on the shank have the similar location, size, shape or orientation. The number of piezo-elements may vary, but should, however, for reasons of balance, amount to at least two.

25

In fig 9, an embodiment is shown according to which the body 1 consists of a bar extension with a circular cross-section intended for milling tools. In this case, a cutting machining element 9 in the form of an edge formed adjacent to a chip pocket 10 at the free end 3 of the bar extension. A piezo-element 8 is attached to the envelope surface 4 of the bar extension in an area near the clamping end 2. The major axis of the piezo-element is parallel to the length extension of the bar extender. Consequently, with this

30



orientation the piezo-element 9 acts most efficiently for dampening of bending vibration also here.

Fig 10 shows another embodiment example where the body or the tool 1 consists of a drill with a shank having a circular cross-section and a so called adapter. A piezo-element 8 is attached on the tool with the major axis thereof at an approx. 45° angle to the length extension of the tool. Thereby, the piezo-element acts most efficiently for dampening of torsional vibrations (compare fig 7).

- 10 For a simultaneous dampening of bending and torsional vibrations, the shank of the tool is advantageously formed with a plurality of piezo-elements of which some are oriented with the long sides thereof essentially parallel to the length extension of the shank, while other are oriented at approx. 45° angle. Alternatively, one or more piezo-elements have other orientations between these orientations in order to individually achieve
- 15 sensitivity for both bending and torsional vibrations.

Piezo-elements are usually fragile, especially those of a ceramic type. Therefore, in demanding environments they should have some form of protection to achieve an acceptable service life. In figs 11-13, a tool shank with a quadratic cross-section is shown, the piezo-elements 8 being attached and protected in alternative ways. In all cases, the piezo-elements are placed in an area near the clamping part 5 (this one may consist of a conventional clamping in which the tool is detachably mounted). In fig 11, the piezo-element 8 is mounted in a recess 11 and advantageously covered by a protective coat, for instance of epoxy type. In fig 12, the piezo-element is assumed to be mounted in the countersink 11 and covered by a stiff lid 12. In fig 13, the piezo-element 8 is mounted, e.g. fixed by cement, on the outside of the shank. These alternatives should only be seen as examples of which the ones shown in fig 11 and 12 are preferred. It will be appreciated that the same type of protection for the piezo-elements is independent of the cross-section shape of the tool shank.

30 According to the invention, the piezo-elements may co-operate with means for electric control or steering of the same. In figs 14 and 15, examples are shown of how the tool 1

has been formed with such control means. In these cases, the tool is mounted in a carrier 13. In fig 15, a control means for passive dampening is shown in the form of a control module 14 formed near the clamping end 2 and an electric connection 15, via which two piezo-elements 8 are connected to the control module 14 for a separate or common control of the respective piezo-element. This module 14 comprises at least electric resistive components. Preferably the control module 14 also comprises one or more shunts, and selected frequencies may be dampened specially effectively.

Fig 14 illustrates a control means for active dampening in the form of a detached logical control circuit 16, e.g. a programmable microprocessor, for separate or common control of (via the schematically shown electric connection 15) the voltage applied over the piezo-element 8. In practice, the connection 15 may in this case comprise collector shoes or the like. Even if the piezo-elements 8 in the embodiment exemplified in fig 14 for active dampening at the same time act as both operating devices and sensors, it is feasible to achieve these two functions by separate operating device and sensors, the sensors do not need to consist of piezo-elements. Although the exemplified location of the control module 14 and the logical control circuit 16, respectively, is preferred, also other locations are feasible. For instance, it is feasible to, like the logical control circuit 16, form the control module 14 detached from the tool. The advantage of placing the control module 14 near the clamping end is that the module is easy to connect to the piezo-elements, while the same at a separate placing becomes easier to protect against harmful mechanical actuation.

A robust tool for chip removing machining with the ability to not only passive but also active dampening of bending as well as torsional vibrations over a wide range of frequencies is provided by the invention. Furthermore, a tool is provided which, on the one hand, presents a longer service life for the tool itself as well as the cutting or machining elements thereof and, on the other hand, brings about an increased quality of the surface on the machined workpiece. In addition, an improved working environment is attained through the reduction of high frequency noise in comparison with previously known tools.

Feasible modifications of the invention

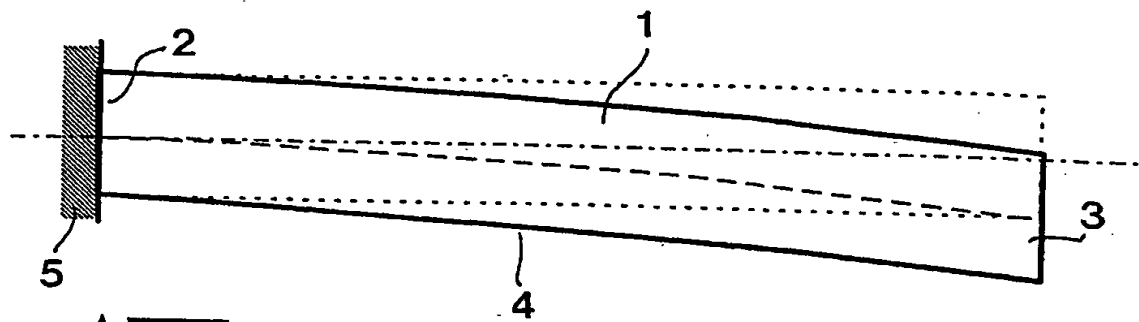
The invention is not solely restricted to the embodiments and applications described and shown in the drawings. Thus, it is feasible to, by active control of the piezo-elements, introduce or reinforce vibrations if these are desirable, e.g. during chip breaking. Relatively large amplitudes may be obtained for introduced or reinforced vibrations with frequencies near the eigenvalue frequencies of the tool.

Claims

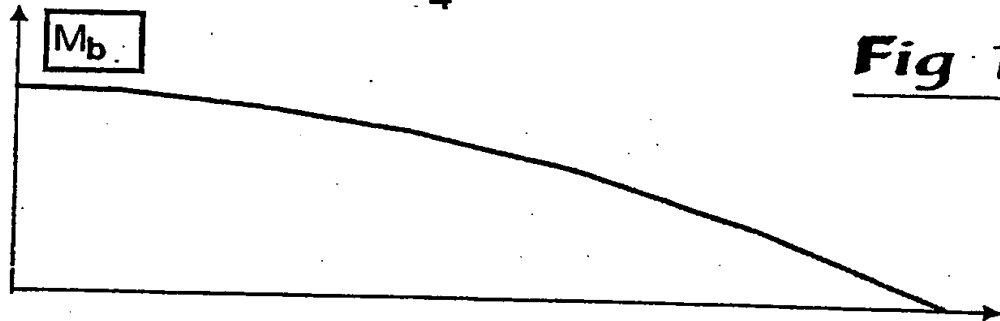
1. Tool for chip removing machining including a shank (1) having a clamping end (2) and having a machining element (9) at an opposite end, characterized in, that  
5 the same comprises one or more piezo-elements (8) having the purpose of dampening vibrations therein.
2. Tool according to claim 1, characterized in, that the piezo-element (8) is  
10 placed in an area near the clamping end (2).
3. Tool according to claim 1 or 2, characterized in, that the piezo-element (8)  
is applied in a recess (11) formed in the tool.
4. Tool according to any one of the preceding claims, characterized in, that  
15 the piezo-element (8) is attached on an external surface of the tool.
5. Tool according to any one of the preceding claims, characterized in, that  
the piezo-element (8) co-operates with a control module (14) having the purpose of  
receiving electric voltage generated by the piezo-element and transform this electric  
20 energy to thermal energy.
6. Tool according to any one of claims 1 - 4, characterized in, that the piezo-  
element (8) is actively controllable through the application of electric voltage from an  
outer voltage source via a control means in the form of a logical control circuit (16).  
25
7. Tool according to any one of the preceding claims, the piezo-element (8) being flat-  
shaped and having a major face in which an appurtenant direction of polarization is  
lying, characterized in, that the major face is essentially parallel to an external  
surface (4) of the tool.

8. Tool according to claim 7, characterized in, that the direction of polarization of the piezo-element (8) is essentially parallel to the longitudinal extension of the tool shank (1) so that the piezo-element primarily dampens bending vibrations.
- 5 9. Tool according to claim 7, characterized in, that the direction of polarization of the piezo-element (8) extends in substantially an  $45^\circ$  angle to the longitudinal extension of the tool shank so that the piezo-element primarily dampens torsional vibrations.

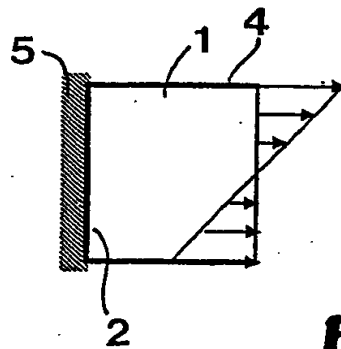
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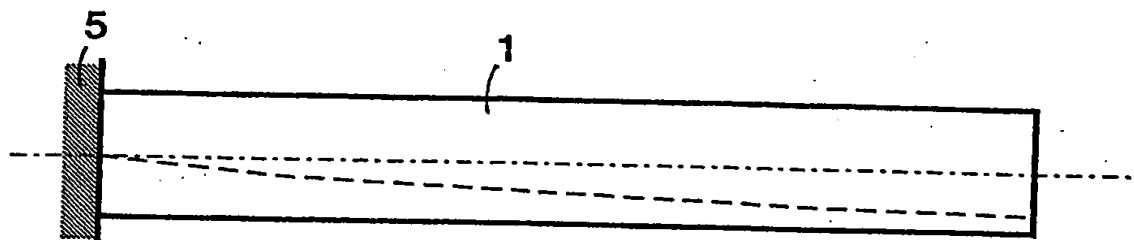
**Fig 1**



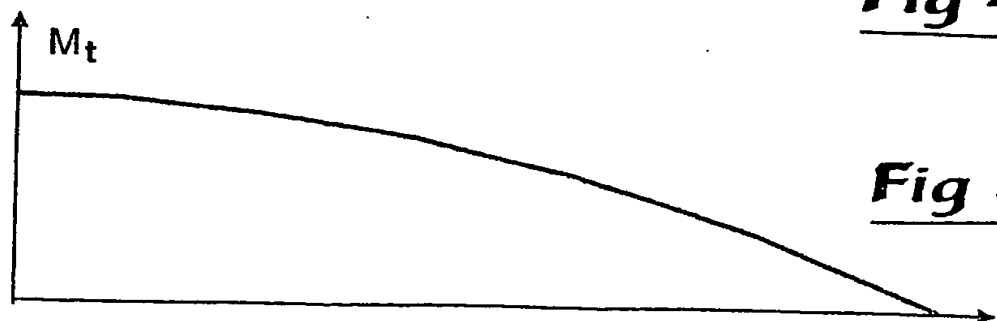
**Fig 2**



**Fig 3**

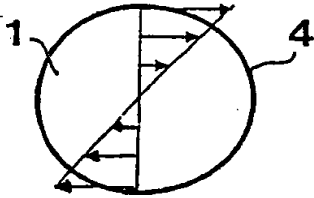


**Fig 4**

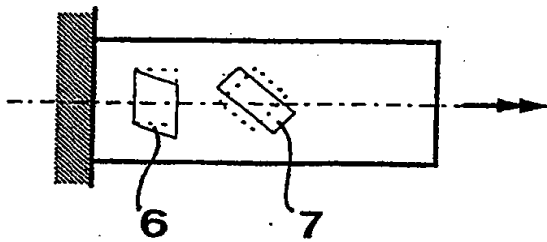


**Fig 5**

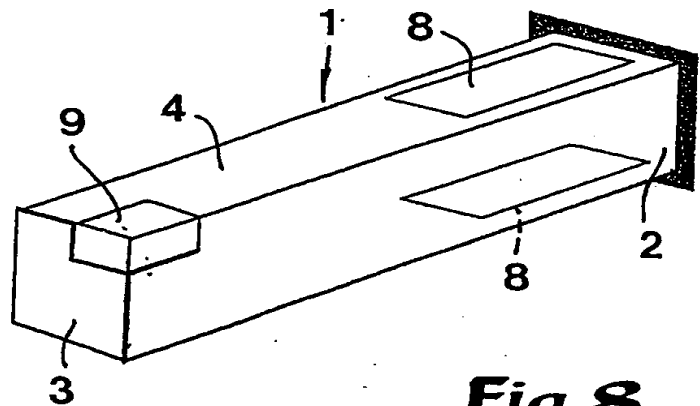
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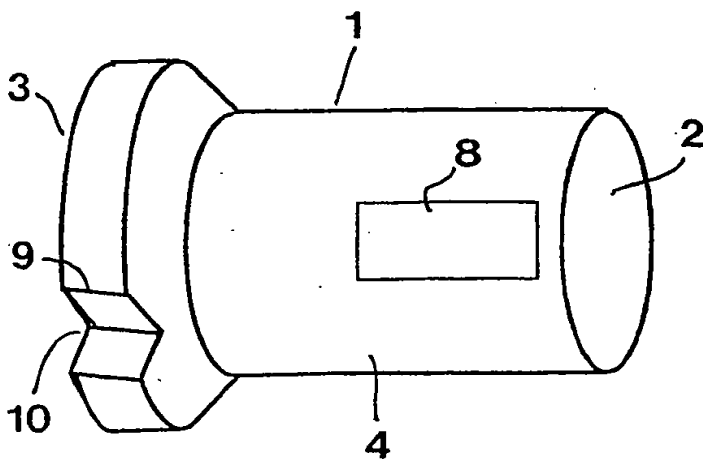
**Fig 6**



**Fig 7**

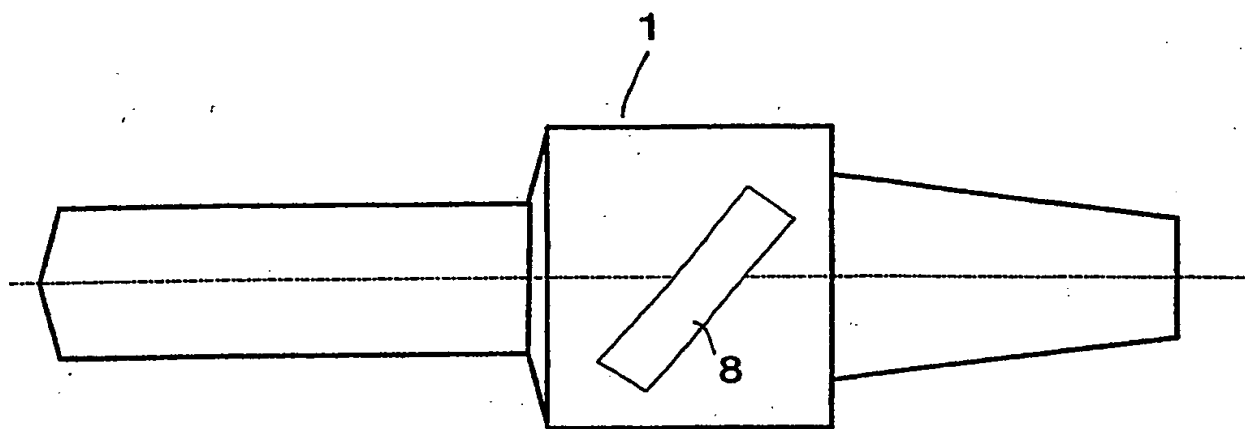


**Fig 8**

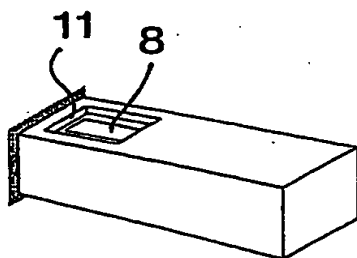


**Fig 9**

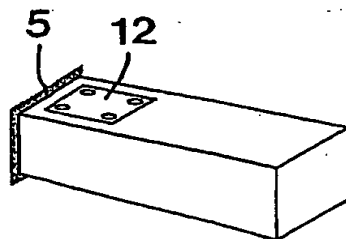
3 / 4



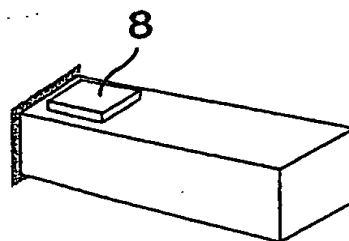
**Fig 10**



**Fig 11**



**Fig 12**

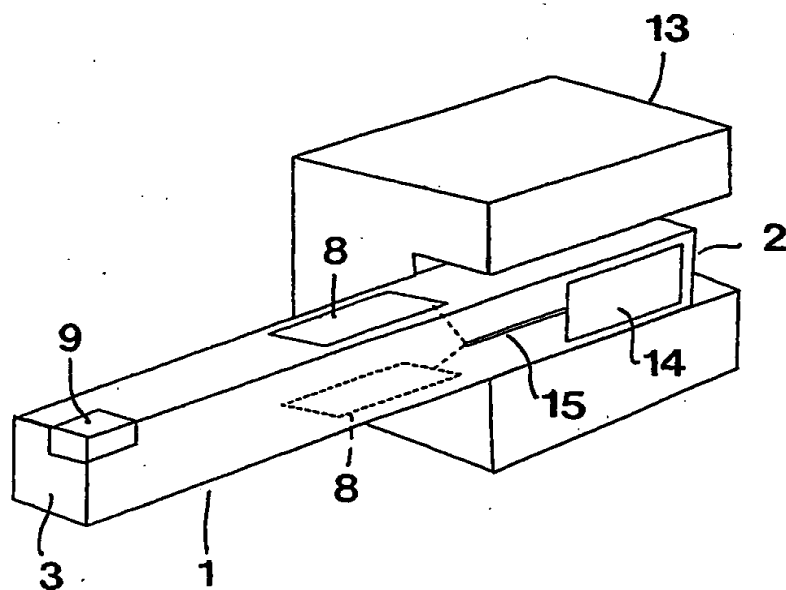
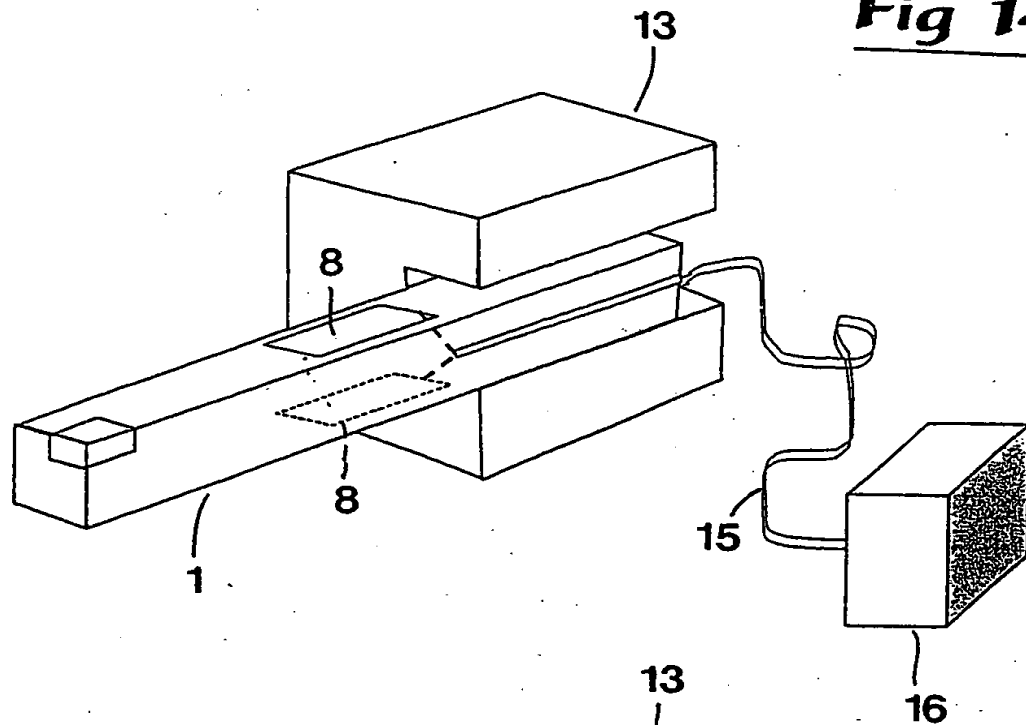


**Fig 13**



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**Fig 14**



**Fig 15**

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE 00/00242

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B32B 29/12, F16F 15/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B23B, B23Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Patent Abstracts of Japan, abstract of JP 63-180401 A (MITSUI ENG & SHIPBUILD), 25 July 1988 (25.07.88)	1
Y	--	2-9
Y	US 4849668 A (CRAWLEY ET AL.), 18 July 1989 (18.07.89), column 4, line 30 - line 32; column 5, line 31 - line 53, figures 2,4, abstract	2-8
Y	US 5485053 A (BAZ), 16 January 1996 (16.01.96), figure 32, abstract	7,9
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document but published on or after the international filing date	"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search	Date of mailing of the international search report
29 May 2000	06-06-2000
Name and mailing address of the ISA: Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer: Joakim Movander/OGU Telephone No. +46 8 782 25 00

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/00242

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,E	SE 9803607 A (INGVAR CLAESSON, LARS HAKANSSON, THOMAS LAGÖ), 22 October 1998 (22.10.98), page 5, line 7 - line 37, figures 2-4, abstract ---	1,3,6-9
X,E	SE 9803606 A (INGVAR CLAESSON, LARS HAKANSSON, THOMAS LAGÖ), 22 October 1998 (22.10.98), page 2, line 6 - page 3, line 12, figure 3, abstract ---	1,3,6-8
X,E	SE 9803605 A (INGVAR CLAESSON, LARS HAKANSSON, THOMAS LAGÖ), 22 October 1998 (22.10.98), page 6, line 36 - page 8, line 3, figures 2,4, abstract -----	1,3,6-9

# INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.

PCT/SE 00/00242

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4849668 A	18/07/89	NONE	
US 5485053 A	16/01/96	NONE	
SE 9803607 A	22/10/98	NONE	
SE 9803606 A	22/10/98	NONE	
SE 9803605 A	22/10/98	NONE	

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference DB 11380 DE	<b>FOR FURTHER ACTION</b>		See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/SE00/00242	International filing date ( <i>day/month/year</i> ) 08.02.2000	Priority date ( <i>day/month/year</i> ) 10.02.1999	
International Patent Classification (IPC) or national classification and IPC <sup>7</sup> B23B 29/12, F16F 15/00			
Applicant Sandvik Aktiebolag et al			

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.  
  
☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 1 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand  31.08.2000	Date of completion of this report  18.06.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer  Eddy Leopold/MP Telephone No. 08-782 25 00

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/00242

## I. Basis of the report

### 1. With regard to the elements of the international application:\*

- ☐ the international application as originally filed
- ☒ the description:  
 pages 1-9, as originally filed  
 pages \_\_\_\_\_, filed with the demand  
 pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☒ the claims:  
 pages \_\_\_\_\_, as originally filed  
 pages \_\_\_\_\_, as amended (together with any statement) under article 19  
 pages \_\_\_\_\_, filed with the demand  
 pages 1, filed with the letter of 24.03.2001
- ☒ the drawings:  
 pages 1-4, as originally filed  
 pages \_\_\_\_\_, filed with the demand  
 pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the sequence listing part of the description:  
 pages \_\_\_\_\_, as originally filed  
 pages \_\_\_\_\_, filed with the demand  
 pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

### 2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language English which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

### 3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

### 4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages \_\_\_\_\_
- ☐ the claims, Nos. \_\_\_\_\_
- ☐ the drawings, sheet/fig \_\_\_\_\_

### 5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/00242

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims	<u>1</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1</u>	YES
	Claims		NO

**2. Citations and explanations (Rule 70.7)**

A new claim is submitted.

The invention relates to chip removing machining, such as turning or drilling and the problem which often arises with vibration, specially in cases where the length of the shank or the tool is at least 4-5 times larger then the diameter therof. One type of vibration is bending vibration and another type is torsional vibration.

The object of the invention is to efficiently damp these vibrations and to stop the build-up of oscillations by regenerative oscillations, where a little more energy is added during each cycle.

This is made possible in that the machining element comprices one or more piezo-elements, in the way claimed, where a certain amount of energy must be removed during each cycle. None of the documents cited in the international search report or any combinations of them, shows a tool for chip removing using active dampening, in the way claimed

Therefore, the subject matter of the invention is novel, is considered to involve an inventive step, and has industrial applicability.

27-03-2001

## Claims

1. Tool for chip removing machining including a shank (1) having a  
5 clamping end (2) and having a cutting insert (9) at an opposite end, plus a number of  
piezo-elements (8) having the purpose of dampening vibrations therein,  
characterized in that a pair of co-operating, flat-shaped piezo-elements (8) with  
lengths that are shorter than that of the shank, are placed on opposing sides of the  
shaft in an area adjacent to the region where the shank is secured in the machine  
10 (2), more exactly in a position close to external surface of the shank, whereby the  
direction of polarization of the piezo-elements is substantially parallel to both the  
longitudinal axis of the shank (1) and its external surface in order that the two  
together can primarily dampen the bending vibrations of the shank , and wherein the  
piezo-elements (8) are actively steerable through the application of a voltage from a  
15 source of electricity via a control device in the form of a logical control circuit (16).